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CENTRAL ROUTING SLIP

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PROJECT

ARGO

"EXECUTIVE SUMMARY"

COPY 1 OF 3 COPIES

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FOREWORD

The ARGO Project was begun in July 1967 as a cooperative venture by the civilian agencies, the Department of Defense and the Central Intelligence Agency. Interest in the use of earth looking satellites for civilian purposes had been growing for some time, and all who were aware of the intelligence systems recognized that the reconnaissance photography ought to be studied by the non-defense users for its contribution to their background knowledge, and possibly, to their needs. This study, then, was designed to give selected resource experts from the civilian agencies that opportunity.

The report that follows documents the analyses and opinions of the scientists and engineers who were selected by their agencies to perform this task. It represents, I believe, a significant achievement by these individuals and by all those agencies whose cooperation made their work possible. It is, however, a report by the individual investigators themselves - it has not been formally reviewed by me or the sponsoring agencies.

In reviewing this report, I think it is important for the reader to note that results from this kind of evaluation fall into two categories.

- Information that can be derived from the imagery, and
- Uses to which this information can be put.

The investigators have documented very well the information of interest to them that can be derived and, as men with wide experience in the activities of their agencies, they have identified some ways in which the information may be useful to current operations. At the same time, it would be unreasonable to expect these few individuals to have exposed all possible information content of the potential uses. Furthermore, with limits on their time and resources, we did not ask them to

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quality their opinions with analyses of the possible costs of acquisition or exploitation. Therefore, the uses they have listed will have varying degrees of significance to the operating agencies, depending on what these costs turn out to be.

Thus, this report is not a comprehensive and final conclusion on the use of exiting space photography for civilian purposes; - rather, it is a point of departure from which the agencies can validate the uses herein suggested and study the derivable information to identify other uses. Indeed, it is only one part of a larger task which must be done to define and develop the uses of overhead sensors.

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Special Assistant ot the President for
Science and Technology

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EXECUTIVE SUMMARY

INTRODUCTION

Interest in the "peaceful uses" of satellite photography dates from 1960, when imagery was obtained by the first successful reconnaissance satellite. Although designed for the purpose of acquiring military intelligence in "denied" areas, the possible use of satellite photography for geoscience applications was quite obvious. Photography currently exists in the files of the intelligence agencies which covers great portions of the earth at resolutions down to 10 feet, and certain areas [redacted] 25X1 To meet intelligence needs for repetitive coverage over regions of interest, the reconnaissance satellites continue to accumulate photographs on a regular basis. Security restrictions preclude its general release, but it has been clear that some investigations were necessary to determine the feasibility of using the photography for non-military applications.

Several concurrent activities have focused attention on this fact over the past few years. Beginning in 1964, the U. S. Army Engineer Topographic Laboratories initiated projects to use the intelligence photography for military geographic analysis and by 1966 had documented applications which were relevant to non-military interests. The Central Intelligence Agency, National Photographic Interpretation Center, and the Defense Intelligence Agency, in support of their analysis of imagery for intelligence purposes, developed and used techniques which seemed to have wider applications. The civilian agencies, through unclassified ground, aircraft and Gemini satellite experiments, were accumulating data to support the use of overhead imagery for resource and geoscience purposes. Finally in 1965, a committee acting under the auspices of National Security Action Memorandum 156, in a review of national policy for satellite reconnaissance, recommended that measures be devised to give the civilian agencies controlled access to information from the reconnaissance systems.

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In response to this developing need, the Special Assistant to the President for Science and Technology took action in November 1966 to begin a formal study of the classified photography by the civilian agencies. With the approval of the Director of Central Intelligence and the Secretary of Defense, and in concert with the Departments of Agriculture, Interior and Commerce, the Agency for International Development and the National Aeronautics and Space Administration, a plan was developed and "Project ARGO" began in July 1967. This is a report on the results of that study.

Objectives and Scope

In initiating the project, the participating agencies had three objectives in mind:

1. To evaluate the information content of the existing photography as it would apply to various physical resource surveys and to determine whether it could be used to meet some current needs of the civilian agencies.

2. To develop within the civilian agencies a cadre of people who would understand the photography and the techniques of exploitation, and who could then assist their agency in making use of the photography and in planning for future systems and applications.

3. To determine whether the existing systems could yield information about the less developed countries of operational value to AID.

The study was performed by a team of scientists and engineers nominated by the participating agencies and representing the disciplinary interests of Agriculture, Geology, Hydrology, Geography, Marine Sciences, Map Products and Engineering. (See Figure 1). To facilitate the evaluation, the full-time participants organized themselves along these disciplinary lines with [redacted] as team leader and wrote individual or, in some cases, group reports in each of the areas.

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The photography that they evaluated was acquired from six camera types from four reconnaissance satellite systems. Examples of the photography, comparative ground coverage and camera characteristics are shown in Figure 2. As the graphic portrayal shows, the DAFF and index cameras of the KH-4 and KH-7 systems cover large areas but with low resolution (poorer than 150 feet). [redacted] 25X1

[redacted] (In the rest of the report, these index cameras are referred to as Index-4, Index-7 [redacted] 25X1

The KH-4 panoramic camera provides about 10 feet resolution and overlapping swaths of photography which can be mosaicked to cover very large areas. The KH-7 camera has the best resolution [redacted] of all the systems considered but photographs a relatively small area. [redacted] 25X1

[redacted] A total of 2,178 separate satellite photographs were used (Figure 3), most of them covering South American areas where AID had special interest, and areas in the United States where good collateral data was available. Wherever available, maps, charts, reports, personal experience and other photographs (Gemini and aircraft) were used by the participants to compare, check and verify their work. 25X1

Advice and technical assistance was provided by the CIA and DoD through NPIC, the DIA, the U. S. Army Corps of Engineers and the Army Map service. The U.S. Army Engineer Topographic Laboratories acted as host to Project ARGO and served as contract monitor to the [redacted] which provided fully cleared office and laboratory facilities, technical support and consulting services to the Project ARGO participants. Administrative coordination was provided by a steering committee comprised of the senior members of each agency team and chaired by the Office of Science and Techology. 25X1

Limitations

The reports that follow are the personal work and technical judgments of the individual investigators. In order to view these reports in their proper context it is important to understand the limitations inherent in the work.

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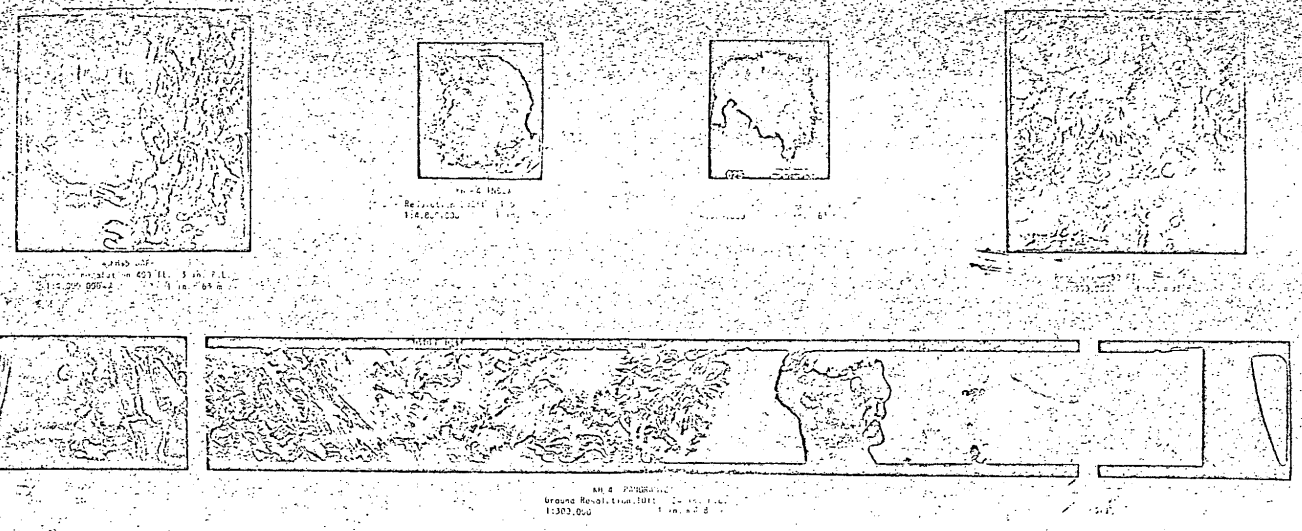

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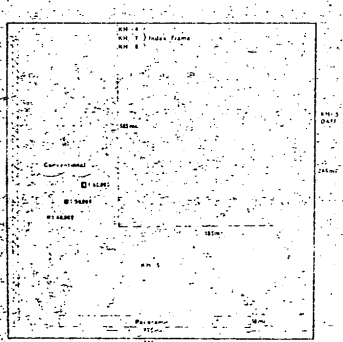

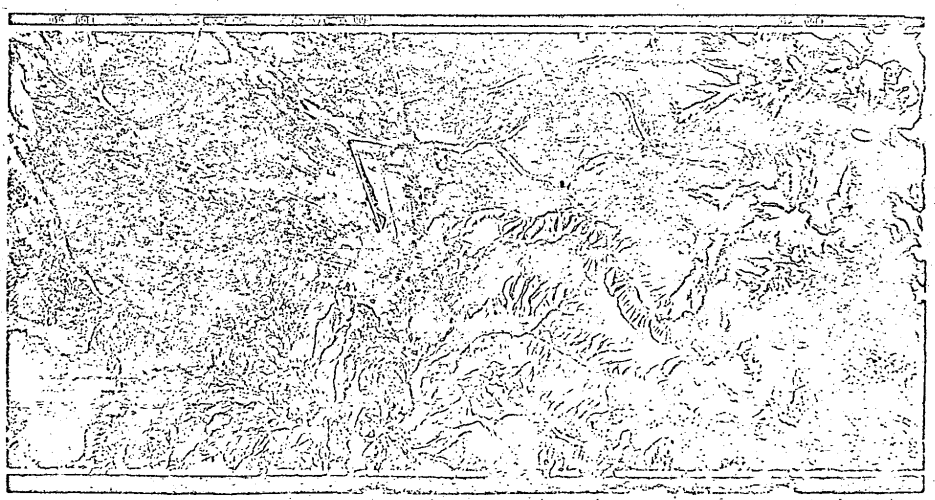

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COMPARATIVE GROUND COVERAGE AND FORMATS

SATELLITE SYSTEMS IMAGERY

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BREAKDOWN OF SATELLITE PHOTOGRAPHY USED IN PROJECT ARGO

SYSTEM	CAMERA TYPE	FILM TYPE	APPROXIMATE GROUND RESOLUTION (IN FEET)	NO. OF INDIVIDUAL FRAMES
KH-5 (DAFF)	Frame	B&W	400	98
KH-4	Panoramic	B&W	10	1,648
	Index (Frame)	B&W	200	196
KH-7	Strip	B&W	[redacted]	42
	Index (Frame)	B&W	160	161
	Strip	Color	[redacted]	4
[redacted]				
			TOTAL	2,178

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Figure 3

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First, the photography evaluated was from systems designed for intelligence purposes and not necessarily optimized for the resource disciplines, either from the standpoint of spectral capability, format, resolution, or the frequency and timing of the coverage. Most of the photography was in black and white; a small amount was in color. The relative value of sensors in other spectral regions was not a subject of this evaluation.

Second, the team members had incomplete access to cost information and were not asked or expected to derive alternative system costs. Thus, their conclusions about utility will be subject to qualification when these costs are later defined.

Third, the participants were selected for their training and experience in their various disciplines and not for their knowledge of satellite systems technology.

In general, then, this report represents the personal judgments of the resource experts who studied the existing photography and evaluated it in terms of its information content and its usefulness to those agency needs with which they have experience. As such, it provides a base from which the agencies themselves can now define more precisely the applicability of the current systems to their operations. It is not and was not intended to be an evaluation of the general usefulness of future satellites systems for civilian purposes.

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INVESTIGATION PROCEDURE

Project ARGO was conducted in three phases as follows:

Phase I - Orientation - An orientation period was conducted to acquaint the participants with the photography, interpretation techniques, and results of previous studies relating to the project.

Phase II - A study of the photography covering a large area of South America containing a wide variety of topography, vegetation and climatic conditions - A Regional Study, dealing with surface drainage, engineering and structural geology, vegetation, surficial materials, surface configuration and land forms, and climatology, was accomplished by Autometric (Shelkin, et al.) for the entire 1.2 million square mile area. Figure 4 shows the area studied. KH-5 (DAFF) and index photography from KH-4 and 7 were used in the regional study. Concurrently, the ARGO investigators performed detailed disciplinary studies on the following representative areas using KH-4 panoramic and KH-7 strip photography:

Area I - consisted of about 30,000 square miles that included parts of Chile, Peru and Bolivia. Desert, high plains and two mountain ranges were the most prominent features. The participants studied the geology, drainage, topography, hydrology, geography and agricultural conditions of the area.

Area II - consisted of about 20,000 square miles of eastern Bolivia that included a part of the eastern foothills of the Andes, an extensive area of tropical forest, and some recent land settlement and agricultural development. Studies in this area concentrated on forestry, agriculture, land clearing and settlement, drainage and hydrology.

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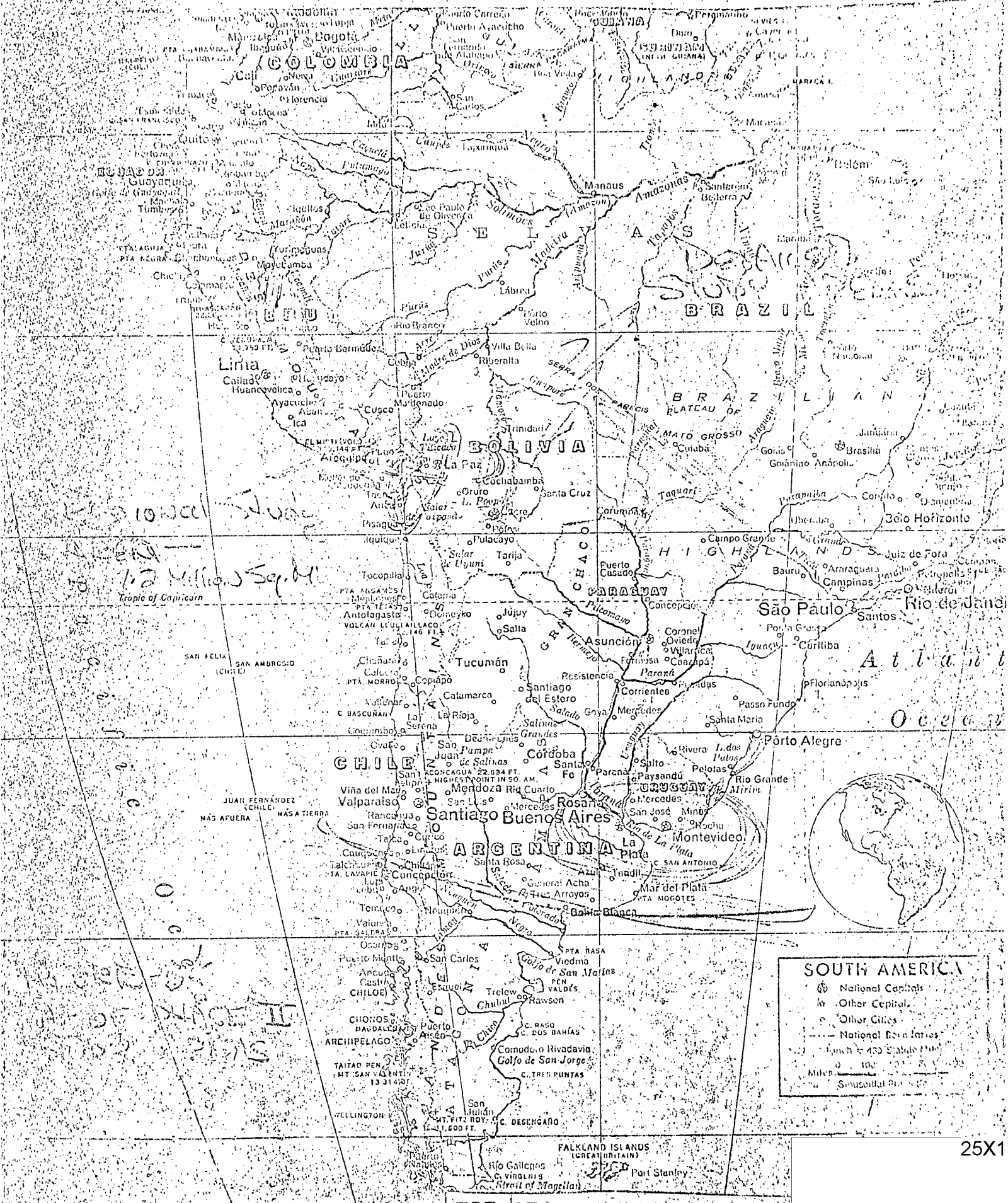

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Area III consisted of some 70,000 square miles, mainly the estuary of the Rio de la Plata in Argentina and Uruguay. Studies in this area were confined mainly to estuarine mechanics, coastal survey, marine sedimentation and wave action.

The studies in Phase II took the form of empirical analyses, with each participant interpreting the imagery for specific information relating to his discipline. As specific details were extracted (interpreted) from the photography, they were recorded on overlays to the photographs and/or photomosaics of the areas. Comparisons were then made between the interpretation results and existing collateral data, and assessments were made in regard to the accuracy and usefulness of the information derived from the satellite photography.

Phase III - The interpretation and evaluation of satellite photography in selected areas where ground truth data was available - Much of the Phase III work was accomplished on sites within the United States and concerned subjects of direct disciplinary or operational interest. Figure 5 contains a listing of areas and subjects analyzed during this phase. The criteria for selection of areas and subjects was based on the availability of suitable ground truth (in the form of previous products, reports, maps, etc., and personal knowledge or experience), adequate satellite photography, and subjects of high interest to the participants and their agencies. The study results were obtained by comparing the interpretations of satellite materials to the ground truth data and forming judgments in regard to accuracy and completeness.

The work was completed in seven months. About one month was devoted to orientation, five months to study, evaluation and reporting and one month to preparation and reproduction of reports and supporting data.

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FIGURE 5

PHASE III - SUMMARY OF AREAS AND SUBJECTS INVESTIGATED

	AREAS	SUBJECTS
1.	Rock Creek Watershed	Land use trends, hydro studies, comparisons of conventional and satellite photos, land use planning.
2.	Sierra Nevada Mt. Range Flat Head Lake	Snow studies, seasonal comparisons cloud structure, runoff estimates.
3.	Phoenix, Arizona Area	Resolution/distortion, acreage measurement
4.	Merced County, California Wasco County, Oregon	Crop acreage measurement, conventional/U-2 comparisons
5.	Cape Cod, Mass State of Rhode Island New England Grand Canyon Petrified Forest	Area studies and sensor comparisons " " " "
6.	Montgomery Co., Md. Lower Rio Grande Valley	Soils Resolution/soils
7.	Ingo County, California	Geology
8.	Sitgraves National Forest King and Snohomish Co., Wash.	Forestry Sensor comparisons
9.	Siberia	Flood analysis
10.	Taiwan, La Paz, Lake Hilluni, Altiplano Achachicala, Chuquiaquillo	Cultural Features " "
11.	S. W. Pennsylvania S. W. Utah Palisade, Colorado Washington, D. C. Santa Cruz	Geography Land use, land patterns, agriculture use, urban dynamics, water and land pollution, archeology.
12.	Iquique, Chile N. W. Territories of Canada Red Sea Grand Exuma Island, Bahamas Northern Coast of Spain Elliott Bay Shoreline Seattle Area, Washington	Ocean surface features Ice and current flow direction Current phenomena Water depth and penetration Hydrographic chart revision Sensor comparison

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SYNOPSIS OF RESULTS

The papers presented in this report have been prepared by engineers and scientists who studied the classified satellite and aircraft photography from the standpoint of different resource disciplines. Although the investigators all started from a common source, they viewed the information content and the potential usefulness from the perspective of their special interests and experience. Their results are therefore not directly symbiotic and any attempt to summarize them presents some difficulties. However, the authors have made some rather explicit points about the uses and limitations of the photography and for the reader who will not be able to read more than just this summary, it seems important to bring these to his attention. For the reader who can afford to spend additional time, a condensation of each author's paper follows this synopsis. For those who wish to follow and understand the analyses in detail, the complete papers and the supporting photography and overlays appear in Volumes II, III and IV.

The Information Content of the Photography

Each team member considered in detail the information content of the satellite photography as applied to his background. In general, as a first step in his evaluation, each author selected categories of information which his experience indicated were of general or special interest to his agency's operations or to his discipline, and for each category evaluated the ability of the current photography to provide all or part of this information.

All authors considered the TK systems to be only a portion of the complete family of tools needed to perform a task or to provide information at some required level of specificity. They point out that the satellite materials should not be expected to solve all problems nor to replace the need for alternate sources of information. Most of the authors have documented their judgments about the contributions to desired

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information that can be supplied by each current system and the reader is invited to their individual papers for a complete discussion. However, the following abstracts are representative of the information capabilities and limitations of the TK photography as described by the ARGO investigators.

Agriculture (Plants and Soils) - [redacted] finds that none of the current panchromatic 25X1
has sufficient information content to be useful for determining plant disease or insect infestation, but that all evaluated photography shows vegetative patterns and land use features. KH-4 and KH-7 can show detailed patterns such as differences between standing crops and bare fields. In regard to crop yield, he finds that KH-7 can distinguish windrows of harvested crops and believes that parameters like this may be useful in making crop yield predictions. No conclusions about standing crop identification or differentiation between standing crops were drawn from the study of the TK photography since timely coverage was not available which would permit collateral verification of species. However, [redacted] in his agriculture summary, 25X1
points out that other experiments have shown that it is possible to differentiate between standing crops of different species.

Agriculture (Crop and Land Use Measurements) - [redacted] finds that the use of mathe- 25X1
matical rectification makes it possible to obtain the required accuracy for crop acreage measurement in the U.S. with the KH-7, although its limited area coverage limits its practicality for this purpose. He reports that the KH-4 pan photography can provide accuracies which may meet domestic requirements in areas like the Great Plains where fields are large.

Agriculture (Forestry) - [redacted] concludes that distinguishing commercial forest land 25X1
from non-commerical forest land is generally beyond the capabilities of all but the KH-7 strip photography, but that the separation of vegetative areas from non-vegetative areas can be accomplished even with the index photography. Forests can be distinguished

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area other vegetation with KH-7 strip and KH-4 panoramic photography. The best resolution of KH-7 strip approaches the minimum required for interpreting components of stand description data. Wildlife management tasks are generally not feasible with any current systems.

Agriculture (Limitations and New Development) - [redacted] report that severe erosion is easily observed on the TK photography, but moderate and slight erosion is difficult to detect; the same situation is true for salinity. They conclude that agricultural information obtained from the KH-4 panoramic photography can be used to good advantage by the planner to delineate areas for development and to permit the concentration of field sampling in selected areas. 25X1

Map Products - According to [redacted] the index frame photographs from the KH-4, 7 [redacted] systems and the KH-5 photographs have little or no value in the geodetic sense in the United States. However, he also points out that in some areas of the world where little or no ground control or geodetic network exists, one can use [redacted] to establish an extensive network of photogrammetric control which has an internal relative accuracy closely approaching what can be obtained with ground control. 25X1 25X1 25X1

Geology - [redacted] states that the geologic information extractable from the DAFF and index photography is so small in amount and so generalized that this photography has little value as a primary source of data. He does indicate, however, that the KH-4 panoramic and KH-7 strip photography provides good information for the geologic understanding of landforms, drainage patterns, anomalies, and physiography and would be useful if aircraft coverage were not available, or for worldwide examinations of specific geologic features such as fault systems. He finds that KH-7 photographs compare favorably in information content with aircraft photography but that KH-7 has no real advantage in width of coverage; and that KH-4 trades something like 25-30% of the geologic [illegible] 25X1 25X1

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content of conventional photography for much more coverage. Because of this combination, he considers KH-4 more useful to geologists than the other TK systems.

Hydrology - [redacted] believe that KH-4 [redacted] photography ca[redacted] 25X1 used for broad water resource planning; for cartographic delineation of flood plains and, when supplemented with KH-7, for detailed water resource development and conservation planning. They point out, however, that space photography cannot in all cases compete with aerial photography if available and cannot replace the need for field investigations for detailed water-resource development and conservation. They conclude that KH-4 has sufficient resolution for sea ice reconnaissance and that a combination of KH-4 [redacted] could be used for snow coverage measurements, flood prediction and water management. They believe that all existing photography provides usable information for cloud formation studies and the delineation of climatologic zones. 25X1

Geography and Cultural Features - [redacted] concludes that the KH-4 panoramic photography can be used for preliminary engineering surveys and route selection, and that the KH-7 strip photography could assist in determining possible highway river crossings and selecting possible damsites. [redacted] believes that to varying degrees, all TK photography has some utility in cartography and in contributions to the physiographic description of the earth's surface. The KH-4 panoramic photography is excellent for thematic mapping and provides good information for land use dynamics and determination of climatic zones by inference. In contrast, the index and DAFF photographs have only marginal utility for thematic mapping, and essentially no utility for urban analysis, air and land pollution studies or determination of climatic zones. 25X1

Oceanography and Hydrography - [redacted] concludes that it is not practical to perf[redacted] 25X1 marine biology and chemical oceanography studies with any of the current systems. The DAFF and index photography is not useful for marine geology studies, for measur[redacted]

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[illegible] shore or subsurface currents, for determining length and direction of wave propagation, or for subsurface topographic contouring. However, he finds that KH-4 and KH-7 can measure ice coverage and ice movement, and suggests the possibility that these systems could aid in studies of ocean water currents and wave motion. He also points out that KH-7 has sufficient resolution to be used for revising nautical charts of harbors and other coastal areas.

Regional Studies - [redacted] concludes that the six geoscience overlays (drainage, geology, vegetation, surficial materials, surface configuration and landforms, and climatology) prepared for a 1.2 million square mile area from DAFF, Index-4 and -7 photography were, in all cases, superior in overall detail to published small scale geologic and USAF Operational Navigation Charts and National Intelligence Survey reports. DAFF photography provided marginal information and was used primarily as a gap filler for areas not covered by the index materials. The very general information resulting from regional studies is greatly enhanced by ground truth and sampling with higher resolution photography.

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Potential Agency Uses

Having determined the information content, each author considered specific ways in which this information might be used by their agencies. Highlighted below are those which seem to merit special attention for additional study.

Foreign Crop Acreage Measurement for Department of Agriculture [redacted] applied the results of the ARGO studies and of other related experiments to the Department of Agriculture's need for data about foreign crop yields and drew the following conclusion. 25X1

"There is a difference in utility for domestic as opposed to foreign applications even though the same information is required. In most cases, if not all, this basic difference is the amount of available ground truth and detail required in the U. S. versus the limited ground truth and the importance of less detailed information in foreign countries. Along with detail goes accuracy of measurements. In the U. S. we have accuracy requirements on some crops to within 1%. However where we do not have acreage control programs the accuracy of our own data is considerably less. In most foreign countries accuracy on the order of 10% would surpass anything presently available in agricultural statistics... The USDA has a vital interest in foreign agriculture. Each year the Secretary of Agriculture has the responsibility of acreage allotments to U. S. farmers for certain crops. Most of these crops are involved in our export market. Information about the worldwide situation for these crops and especially about our major competitors would be invaluable data. A statistically valid sampling procedure for these countries could be employed to reduce the data handling to manageable proportions... The major food crops of the world, their geographic distribution, their harvesting methods, their climatological requirements for planting, sprouting, full growth, and harvesting are all known parameters. Satellite photography permits us to monitor this evolution, to measure the acreage and predict to within a certain degree of accuracy the potential yield."

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D. Use for Less Developed Countries

From the findings of the ARGO investigators and from the results of work done elsewhere [redacted] draws conclusions about the photography's potential utility to AID for agricultural assessments, population estimates and as a base for fiscal estimates and tax assessment formulae. 25X1

1. Agriculture

"The ARGO study shows that acreage measurement of areas under cultivation is feasible from satellite photographs, provided a small amount of additional information obtained directly from the ground is available. The technique has been refined to a point where some degree of differentiation between crops is feasible, permitting selective measurements by crops. The degree of accuracy of acreage measurement required in the U. S. is not needed for AID purposes in less developed countries. As noted in a recent analysis by USDA's Economic Research Service, present inaccuracies in LDC crop estimates often exceed 30%, so there is little question that satellite photography such as KH-4 and KH-7 can provide significant improvements. What is insufficiently known at this point is the amount of supplemental "ground truth" information required to achieve a stated level of accuracy in crop and acreage estimates."

2. Population Estimates

"Based on tests over U. S. areas, remarkable demographic estimates have been obtained from aerial photographs augmented by limited ground sample information. These estimates have covered a variety of dwellings and urban configurations. They have included estimates of net population size, changes in population size due to migration and changes due to the birth and death process. All are of interest to AID. The full extent to which satellite photography and photointerpretation

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techniques may be used in the LDC's (Less Developed Countries) remains to be determined; but vast improvements in demographic estimates can be expected. This would constitute a major breakthrough in an area of vital concern to AID and other [illegible] organizations, as was underscored by the President's Science Advisory Committee's report of May 1967 on the World Food Supply which states that "There are no recent censuses for many Asian, African, and Latin American countries... (for example) Pakistan's population, according to one estimate, was undercounted by nearly 8 million (7.6 percent of total population) in the census of 1961...Of even greater significance to a study of the future relationship of population and food supply is the rate at which the population is growing. Unfortunately, estimates of present growth rates for much of the world are of doubtful reliability or are simply not available..."

3. Tax Base Information

"Satellite photography, covering very large regions, or in some cases, entire countries, constitutes unique source material for arriving at fiscal estimates of income under various tax assessment formulae. Whereas individual properties, except for very large holdings could not be positively identified on such photography, areal measurements of current land use can be extracted. Applying assessment criteria to the various classifications of current land use would permit national estimates of potential revenue to be computed quickly. Since few or none of the LDC's are covered completely by aerial photography, there are no means of developing, realistically, estimates on revenues that could accrue from a national real estate tax program. Such evaluations would, furthermore, locate areas of greatest potential income from real estate taxation which could be realized by initiating a bona fide fiscal cadastral survey employing large-scale aerial photography at which time individual property ownership would be determined and [illegible] accomplished."

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For each of these areas [redacted] recommends that a "live problem" be studied to more precisely define the accuracy with which these tasks could be accomplished. 25X1

Snow Coverage Measurement - Farble et al. point out that snow coverage in the mountain areas is presently measured by the Soil Conservation Service, the U.S. Weather Bureau and the Forest Service by means of ground measurement and some aircraft photography. "The techniques are costly and time consuming; more accurate data are desirable for flood and water yield forecasting. By using KH-4 pan [redacted] index photography 25X1 it should be possible to gather this needed information on a rapid and timely basis." As an example of this application the authors referred to the problem faced by California during the late spring of 1967. "Late storms had deposited record snow depths and water equivalents for so late in the year. Daily forecasts of snow melt and long-range outlooks of total water remaining in the snow pack were called for...Very limited data were available and daily or even weekly ground surveillance was almost impossible to obtain. So, very rough estimates had to be made based on very sparse data. As a consequence, a considerable amount of water was wasted by being released to run to the sea which could have been stored if more accurate data had been in the hands of the forecasters..."

Another example refers to the problem often faced in the plains areas of the midwest when a heavy mantle of snow is deposited. "Limited observations of snow depth and water equivalent hamper the preparation of adequate river forecasts in cases where rains combine with rapid warming to melt the snow in a very short period of time. This snow melt water contributes materially to the total runoff and has many times resulted in disasterous local flooding which is largely unpredicted. Good high resolution photography over large areas which would be available from space vehicles could provide information to assist the flood forecaster in his evaluation." At the same time the authors caution that "a careful study which compares efficiency, costs, etc., of space systems photography to [illegible] airplane photography must be undertaken prior to making any [illegible] merits of obtaining such information from satellites." 25X1

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Pacific Forest Survey for the Department of Agriculture - [redacted] points out that as a data source, the KH-4 and KH-7 system imagery "does not measure up to the conventional aerial photography currently being used" and that separating forests from other major vegetation is possible but moderately difficult with KH-4. At the same time, he believes that this photography and aircraft imagery can supplement each other to give more effective use in forestry applications. As an example, he cites the nation wide forest inventory program which is conducted by the Department of Agriculture. He believes that "if KH-4 panoramic imagery were made available on an annual basis it could materially change the existing program...The land use base could be updated and trends easily identified. Most timber depletion could be pinpointed and efficient sampling procedures developed." 25X1

Water Resource Planning - [redacted] regard the KH-4 panoramic photographs as being a good data base for water resource development plans and believe that KH-4 panoramic, supplemented by KH-7 strip [redacted] could be used "to prepare detailed...plans such as those developed by the Soil Conservation Service, the Bureau of Reclamation or the Corps of Engineers." They also feel that the "cartographic delineation of flood plains, as is frequently done by the U. S. Geological Survey, the Soil Conservation Service and the Corps of Engineers is one of the immediate uses to which existing KH-4 pan [redacted] material could be put." 25X1 25X1

Other Applications - A number of other uses are also mentioned. [redacted] all agree that the KH-4 panoramic and higher resolution systems would be useful for sea ice studies, monitoring and forecasting. The hydrologists conclude that one-time coverage of all ice [illegible] would provide data for more accurate determination of the global water [illegible] and weekly coverage would provide data on sea ice conditions and [illegible] is of great interest for commercial operations. 25X1

[redacted] 25X1

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Hanshaw et al. point out that the low resolution of current weather satellites preclude their use for detailed study of cloud structure and small storm systems. They conclude that "Talent-Keyhole photography could open up wide vistas in these studies. This data should be exploited as soon as possible."

[redacted] recommends the use of [redacted] photography for provisional [redacted] 25X1

geodetic control of developing countries and states that such "geodetic control data cannot be obtained in any other manner in an acceptable time frame."

[redacted] believes that existing KH-7 strip imagery could find practical use 25X1

in the revision of shoreline and land features of the U. S. Coast and Geodetic Survey charts.

[redacted] concludes that KH-4 panoramic supplemented by KH-7 strip coverage 25X1

would be useful for urban analysis, land use analysis and transportation studies.

[redacted] conclude that index photography can be used for 25X1

regional studies involving landforms, general land use and drainage. [redacted] 25X1

[redacted] y concur on the usefulness of 25X1

DAFT and index for small-scale mosaics as a planning tool or as a data base.

[redacted] 25X1

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GENERAL CONCLUSIONS

In reading the papers, one finds that there are a number of topics about which most of the authors were in agreement.

1. There is general agreement that the present intelligence systems can be useful to current agency opearations. The authors are careful to qualify this conclusion, however, by noting that the degree of this utility will depend on the cost of exploitation and on the limitations that security classification might place on the handling of the information. In regard to the cost, it was generally assumed that the bulk of the system operation costs would be borne by the intelligence community but it was recognized that exploitation costs would have to be defined and considered for each potential application. Opinions about security limitation varied according to the applications envisaged and the current operating procedure of the agency. Where current procedure makes wide distribution of the photography itself - as in the ASCS, for example - security poses a serious problem unless the agency procedures can be modified. On the other hand, where only a few people need access to the photography or where only derived information is distributed, security may be no problem at all.

2. Most of the investigators found that color enhances the value of the photography to a considerable extent. [redacted] for example, says that "The design of the TK camera systems and the selection of their film, although optimum for military intelligence requirements, definitely does not provide optimum photography of earth resources - particularly vegetation. The TK camera lens design (peaked in the red) and filter selection (red filters) optimizes the red part of the spectrum. Green vegetation thus appears almost uniformly black on panchromatic film. [redacted] comments that "Checking acreage measurements and field changes would be enhanced with color film." Several authors have recommended that color film be used [redacted] of the two panoramic cameras of the KH-4 system.

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3. In general, the team was not prepared to make categorical statements about the value of various levels of resolution. Many of the investigators were impressed by the vast area synoptic view provided by mosaics using the low resolution index cameras and its value as a basis for regional planning for the identification of areas for which more detailed information might be desired. At the same time, most of the specific applications that were identified by the team made use of the higher resolution KH-4 and KH-7 systems (about 10 feet [redacted]. The investigators were generally reluctant to give up what they considered a major advantage of satellite photography - large area coverage. Although the KH-7 gave more detailed information because of its higher resolution, most authors considered the KH-4, which is a panoramic camera with large area coverage, to be a better system for most of their purposes. [redacted] make the point specifically when they say that the "usefulness of each system is not solely and directly related to resolution. For instance, the KH-4 photography would be of more use to hydrologists than KH-7. This is because the KH-4 provides readily rectifiable photos which cover very large areas and have relatively good resolut

Most authors discussed how the timeliness and frequency of coverage affected its usefulness and expressed opinions which varied widely according to the particular application and interest. Some interests were served by exploiting the photography already on hand. Most required new coverage targeted for particular areas and at particular times. Many required repetitive coverage and timeliness. For example, [redacted] felt he could use the imagery presently on hand as a data base with which to compare future worldwide coverage for the study of long term effects. The [redacted] can use existing photography for delineating flood plains, but wanted [redacted] coverage six times annually for snow cover determination and flood [redacted] coverage for flood damage surveys. All natural disaster [redacted] coverage, but the geologists [redacted] one-time KH-4 coverage [redacted]

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for the study of the world's fault system as an aid to the understanding of earthquake mechanisms. [redacted] makes the point that "Agriculture is dynamic in that plant and soil conditions are constantly changing." Crop acreage, yield estimates and estimates of stress would require scheduling of coverage during specific periods of the growing season. For forestry applications such as land use dynamics and timber depletion, annual coverage would be desired, but for forest inventories, coverage every five years would suffice. Oceanographic studies, such as those involving polar sea ice, may require coverage at intervals of an hour, a day, a month or longer, and repetitive coverage for chart revision may only be required at five to ten year intervals.

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